UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Southeastern Area, State and Private Forestry
Atlanta, Georgia 30309

3580
September 29, 1975

Mr. Ralph Winkworth, Director
Division of Forest Resources
Department of Natural and Economic Resources
P. O. Box 27687
Raleigh, North Carolina 27611

Dear Ralph:

The Federal Water Pollution Control Act Amendments of 1972 have caused us to ask questions about the nature, extent and magnitude of pollution from forest land in the Southeast. Sediment is the major water quality impact of forest land management, which has been evaluated in 14 river basin studies over the past six years.

The field data from these studies has been stored in a data bank. George Dissmeyer has analyzed the data bank, extracted results from the river basin reports and summarized these findings in an article. Enclosed for your information is an advanced copy of his paper describing the nature, extent and magnitude of sediment impacts of forest management in the Southeast.

Sincerely,

SIDNEY WEITZMAN
Area Director

Enclosure

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EROSION AND SEDIMENT FROM FOREST LAND USES, MANAGEMENT PRACTICES AND DISTURBANCES IN THE SOUTHEASTERN UNITED STATES 1/

1976

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ABSTRACT

The data and information presented defines the nature, extent and magnitude of erosion and sediment sources from forested in several river basins in the Southeastern United States. Data shows that not all sediment from forest land is related to silviculture, but in some areas past abusive agriculture and present woodland overgrazing are the most important sources of sediment. It shows that forest practices acts, which contain blanket regulations, are likely to be inappropriate for some areas, insufficient for others or sometimes unnecessary. Control of forest sediment needs to be prescriptive and site specific in nature to meet not only water quality, but other resource needs.

INTRODUCTION

With passage of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500), forest land managers need to know the nature, extent and magnitude of pollution from individual forest land uses and disturbances. With such information, they can adjust forest practices to accommodate water quality goals.

What do we know about sediment yield from forest land in the Southeastern United States? During the past seven years, erosion and sediment have been evaluated in 14 river basin studies (Map 1). Here, nearly 5,000 field plots have been sampled to determine the nature, extent and magnitude of erosion and sediment problems associated with various forest land uses and forestry practices. This data has been analyzed by using the First Approximation of Suspended Sediment (FASS) procedure (Dissmeyer, 1973), which approximates the suspended sediment contribution of individual forest land uses or disturbances by associating back to the land units their proportional share of measured sediment output.

1/ Presented at the Third Inter-Agency Sedimentation Conference. Denver, Colorado, March, 1976.

PERSPECTIVE

One of the first questions to be answered is the matter of perspective: what percent of the total sediment yield comes from forest land as compared to nonforested lands? In seven basin studies where the analysis are complete, forests occupy from 18 to 68 percent of the area (TABLE 1), while the percent of total sediment yield produced by forest land ranges from 1 to 24 percent. This does not include stream channel erosion. Perspective can best be gained by computing the ratio of percent sediment production to percent of forest, which ranges from 0.03 to 0.35. The smaller the ratio, the smaller the relative contribution of forest land to sediment production. A ratio of 1.00 would mean that the forest was yielding sediment at the same rate as nonforested lands.

The two highest ratios occur in the Alabama and Obion-Forked Deer River Basins, where intensive mechanical site preparation and woodland overgrazing with high erosion rates are the causes, respectively. More discussion on individual sources of sediment will come later.

NATURE AND EXTENT OF FORESTRY PRACTICES AND LAND USES

When looking for sources of sediment in forest land, one must realize that the vast majority of the forest is undisturbed and not yielding more than natural levels of sediment from watershed slopes. The term undisturbed as used here does not mean virgin conditions, because most forest land has been disturbed sometime in the past. The term is used to describe the area that has not been disturbed in the past two to five years and the area is experiencing only natural erosion rates. For the nine basins for which area data has been developed, the area of forest in the undisturbed condition ranges from 69 to 94 percent (TABLE 2).

The percent of area logged each year varies due to the type of timber, the products grown and rotation. The area experiencing erosion and yielding sediment is a function of area cut and time required to heal disturbances. In the Southeast, the area experiencing erosion from logging ranges from 4.1 to 12.0 percent (TABLE 2).

The area experiencing erosion from skid trails landings and spur roads was considered as a separate category from the logging area, because different control strategies are needed. Also, these areas tend to have somewhat longer recovery periods than areas where the trees are felled and removed. The area in spur roads, landings and skid trails ranges from 0.1 to 5.1 percent of the forest area.

It should be noted here that not all spur roads found were exclusively used for logging. A portion of these roads are used for farm management, recreation, fire control, etc.

The percentages in skid trails and spur roads vary widely, because of differences in terrain among land resource areas (LRA), types of products being harvested and harvesting systems. The area in skid trails and spur roads, expressed as a percent of the logged area, by land resource area is presented in TABLE 3. In LRA's 131, 133, 134, 137 and 153, the primary product harvested is pulpwood in either thinnings or clearcuts. Here trees are felled and the pulpwood is usually stacked without skidding. Then trucks drive across the land to pick up the piles of pulpwood. Therefore, the area of skid trails is small. Also, because the trucks drive across the land, few spur roads are needed. Exceptions are where whole tree chippers are used and where sawlogs are harvested, which require skidding. However, such areas commonly are mechanically site prepared for planting, and skid trails and roads are obliterated.

In hilly and mountainous LRA's such as 120, 122, and 128 where hardwoods are harvested for sawlogs, roads are built to gain temporary access to timber, and logs are skidded to landings. Here, skid trails and spur roads can occupy between 9.5 and 25.2 percent of the logged area.

Fire includes both wildfire and prescribed burns. The area experiencing erosion from fire ranges from 0.3 to 10.5 percent (TABLE 2). When forests are managed for pine, fire is an important tool in controlling hardwoods. Also, fire is used to improve quail habitat.

Mechanical site preparation is used to prepare a site for planting pine. After a stand is harvested, the residual noncommercial pine and scrubby hardwoods are felled using heavy equipment. A variety of treatments are used including the following: chop; chop and burn; chop, burn and bed or disc; KG-blade, windrow and burn; KG-blade, windrow, burn and bed or disc; and bulldoze, windrow and burn. This is not an all inclusive list, but it does show the intensity of some treatments. The area in each basin experiencing erosion from mechanical site preparation ranges from zero to 4.0 percent.

Finally, the area experiencing woodland grazing ranges from essentially none to 13.4 percent of the forest land. Grazing is a viable and proper forestland use in some pine forests, but causes problems in hardwood forests. It is important to note that not all forest disturbances are exclusively related to silviculture.

RECOVERY TRENDS

An important concern in evaluating sediment from forest land uses and practices is how fast the affected areas heal. Disturbances from a few days to several years old were field sampled and the recovery trends

in cover factors (C-factor) were analyzed. Recovery trends are summarized by LRA and depicted for various forestry practices in TABLE 4. The recovery periods vary from 2 to 5 years.

In Column 8, the average cover-factor for the recovery period is presented. Note that undisturbed and grazed conditions are assumed to be static conditions and thus no recovery trend or period are defined.

A special problem in recovery trends is found for spur roads. Here, no trend can be defined because these roads are often not allowed to heal. They are used by the farmer for managing his farm; by hunters, jeepsters, and cyclists, and by forest managers and fire control personnel.

The number of plots taken in each condition is entered in Column 9 to indicate the relative reliability of the data. Some situations have strong data bases, and others are weak and shall be strengthened by future sampling.

REPRESENTATIVE EROSION RATES AND ESTIMATED SEDIMENT PRODUCTION RATES

Where sufficient data has been collected, representative erosion and estimated sediment production rates were computed (TABLE 4). From the data bank, the predominate soil was selected from each land resource area. For each soil grouping in the data bank, with its basic erosion rate (K); the average rainfall factor (R), slope (S) and slope length (L) were computed. Using these average values plus the average cover factor for the recovery period, a representative sheet erosion rate was computed using the modified Musgave soil loss equation,

$$E = KCR \left(\frac{S}{10}\right)^{1.35} \left(\frac{L}{72.6}\right)^{.35}$$

(SCS, 1968) and is entered in Column 10. This rate approximates the middle ground for erosion from a forestry practice in a land resource area.

When the practices were field sampled, the observers estimated what proportion of the erosion reached the nearest stream (sediment delivery ratio) using techniques described by Dissmeyer (1973). For each practice and land resource area, a recovery trend in estimated sediment delivery was computed by slope class. An average sediment delivery ratio was computed for the recovery period and multiplied times the representative erosion rate to produce the estimated sediment production rate in Column 11. Col #10

RELATIVE CONTRIBUTION OF FOREST PRACTICES

The relative contribution of each forest management practice to sediment yield in eight completed studies is shown in TABLE 5, along with the

weighted average erosion rate for forest land in each basin. In three basins, average suspended sediment data was available and the portion contributed by forest land management has been approximated in parts per million using the FASS procedure.

The FASS procedure also identified what percent of the sediment yielded by forest land comes from each forestry practice or land use (TABLE 5). The results presented here clearly demonstrates that major causes of sediment vary from river basin to river basin. In some cases mechanical site preparation is the most important; in others, woodland overgrazing; and others spur roads and skid trails.

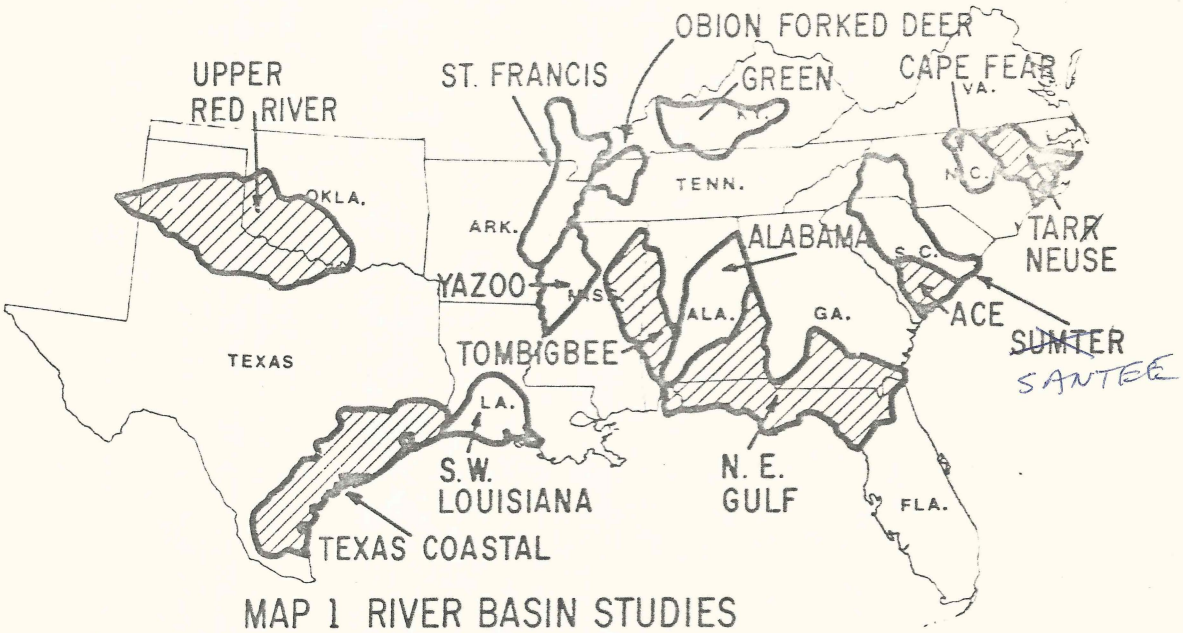
Also in the Southeast, not all sediment from forest land is from silviculture practices. In some areas, woodland overgrazing is clearly the major source of sediment. In other areas, former agriculture wore out and gullied the land. These lands were abandoned and forests either invaded or over planted. These lands are still eroding and the sediment is not due to present forest management, but past agricultural abuse.

Finally, this data clearly shows that forest practices acts, which contain blanket regulations, are likely to be inappropriate in some areas, insufficient in others or sometimes unnecessary. Control of sediment must be prescriptive and site specific in nature to meet not only water quality, but other resource needs. In some cases, more attention should be given nonsilvicultural land uses than to forestry.

REFERENCES

Dissmeyer, George E., 1973. Evaluating the Impact of Individual Forest Management Practices on Suspended Sediment. Plants, Animals, and Man, Proc. 28th Annual Meeting, Soil Conservation Society of America, September 30 - October 3, 1973, Hot Springs, Arkansas, Pages 258 - 264.

Soil Conservation Service, 1968. Guide to Sedimentation Investigations. SCS Engineering and Watershed Planning Unit, Forth Worth, Texas.



MAP 1 RIVER BASIN STUDIES

Sediment analysis completed Field data collected only

TABLE 1 Relative Contribution of Forest Land to Total Sediment Yield

River Basin	% of Total Sediment	% of Basin In Forest	Sediment Yield Ratio
Alabama	24	68	.35
Cape Fear	6	68	.09
Green	2	34	.06
Obion-Forked Deer	8	24	.33
Santee	10	69	.16
St. Francis	3	18	.17
SW Louisiana	1	39	.03

TABLE 2. Percent of Forest Land Experiencing Erosion From Various Causes By River Basin

River Basin	Undisturbed	Logging	Skid Trails Spur Roads and Landings	Fire	Grazing	Mechanical Site Preparation
Alabama	86	4.8	1.8	2.5	3.4	1.6
Cape Fear	93	4.1	1.0	1.6	Trace	0.5
Green	78	7.5	3.1	1.6	10.0	0.0
Obion-Forked Deer	81	9.0	5.1	0.5	4.4	0.1
Santee	94	4.5	0.1	0.7	Trace	0.5
St. Francis	78	12.0	1.1	0.7	8.0	0.3
SW Louisian	69	6.1	0.5	10.5	13.4	Trace
Tar - Neuse	89	4.5	0.4	0.3	1.1	4.0
Yazoo	72	12.0	0.4	3.5	12.1	0.1

TABLE 3. Percent of Logged Area in Skid Trails and Spur Roads by Land Resource Area

Land Resource Area	Percent of Logged Area in: Skid Trails	Spur Roads	Total Area-%
Texas Claypan Area (87)	1.5	-	1.5
Central Miss. Valley Wooded Slopes (115)	1.3	7.0	8.3
Ozark Highland (116)	1.8	3.5	5.3
Ky. & Ind. Sandstone & Shale Hills & Valleys (120)	3.9	12.7	16.6
Highland Rim & Pennyroyal (122)	8.1	17.1	25.2
Southern Appalachian Ridges and Valleys (128)	8.3	1.2	9.5
Sand Mountain (129)	4.1	2.2	6.3
Blue Ridge (130)	3.0	2.2	5.2
Southern Miss. Valley Alluvium (131)	0.0	9.4	9.4
Southern Coastal Plain (133)	3.3	3.3	6.6
Southern Miss. Valley Silty Upland (134)	Trace	4.2	4.2
Ala. & Miss. Blackland Prairies(135)	6.1	7.3	13.4
Southern Piedmont (136)	4.3	1.9	6.2
Carolina & Ga. Sand Hills (137)	2.5	1.5	4.0
Atlanta Coast Flatwoods (153)	1.7	2.3	4.0

TABLE 4. Average Cover Factor; Recovery Trends in Cover Factors, and Representative Erosion Rates for Various Forest Land Uses and Conditions by Land Resource Areas in Southeastern United States

(1) Land Resource Area	(2) Land Use or Condition	(3) Average Cover Factors by Year During Recovery Period: First Year	(4) Second Year	(5) Third Year	(6) Fourth Year	(7) Fifth Year	(8) Average Cover Factor for Period	(9) Number of Plots	(10) Representative Erosion Rate T/A/Y	(11) Est. Sediment Productive 1/ T/A/Y
Central Rolling Red Plains (78)	Undisturbed						.301	-	.02	.01
	Grazed						.11	11	.68	.04
Central Rolling Red Prairies (80)	Undisturbed						.008	14	.06	.00
	Grazed						.006	-	.06	Trace
Oak - Timbers (84)	Undisturbed						.004	51	.11	Trace
	Grazed						.013	14	.63	.00
Grand Prairie (85)	Undisturbed						.007	47	.51	.11
	Grazed						.007	41	.51	.11
Texas Blackland Prairie (86)	Undisturbed						.017	1	.33	Trace
	Grazed						.05	-	1.37	Trace
Texas Claypan Area (87)	Undisturbed						.020	34	.38	.14
	Grazed						.140	17	4.35	Trace
Central Miss. Valley Wooded Slopes (115)	Undisturbed						.004	44	.01	Trace
	Grazed						.008	18	1.61	.08
Ozark Highland (116)	Undisturbed						.006	79	.02	.00
	Grazed						.329	8	14.08	10.56
	Logged	.182	.032	.010			.075	30	7.77	.34
	Spur Roads	.550	.158	.023			.244	19	15.14	3.03
	Skid Trails	.610	.020	.033			.221	8	17.09	.51
Kentucky and Indiana Sandstone and Shale Hills and Valleys (120)	Undisturbed						.004	106	.33	Trace
	Burned	.083	.028	.008			.119	11	9.68	.00
	Grazed						.037	8	3.01	.30
	Logged	.018	.005				.012	8	.98	.00
Highland Rim and Pennyroyal (122)	Undisturbed						.004	143	.51	Trace
	Grazed						.203	35	25.77	10.31
	Logged	.014	.015	.013			.014	24	1.78	Trace
	Spur Road	.525	.360	.300		.800	.422	13	52.94	26.47
Southern Appalachian Ridges & Valleys (128)	Undisturbed						.003	28	1.29	.00
	Burned	.006	.005				.005	13	2.15	.00
	Logged	.051	.024	.009			.030	35	12.87	.39
Sand Mountain (129)	Undisturbed						.002	28	.91	Trace
	Logged	.049	.112	.004			.052	15	23.54	2.82
Blue Ridge (130)	Undisturbed						.002	8	.77	.00
	Logged	.058	.007				.033	32	12.76	.64
	Skid Trails	.950	.345	.133			.476	7	105.20	42.08
Southern Miss. Valley Alluvium (131)	Undisturbed						.012	77	3.14	.09
	Grazed						.181	14	47.29	18.28
	Logged	.012	.012			.016	.013	9	3.40	.10
	Spur Road	.899	.015				.453	4	59.85	.00
Southern Coastal Plain (133)	Undisturbed						.009	722	.53	.00
	Burned	.117	.055	.005			.058	57	3.46	.71
	Grazed						.071	80	4.17	2.43
	Logged	.113	.096	.021	.010		.060	240	3.52	.32
	Landings	.690	.950	.450			.697	19	16.7	5.08
	Spur Roads	.712	.435	.251	.005		.401	45	20.21	6.27
	Skid Trails	.433	.567	.333	.003		.334	43	14.29	4.41
	Chopping	.430	.272	.005			.236	26	4.84	.78
	KG Blading	.992	.700	.276	.133		.529	11	30.83	12.5 — 40%
	Bulldozed	.792	.817	.266	.004		.484	38	27.61	8.28 — 30%
	KG & Disced	.750	.583	.333	.020		.388	9	22.29	10.03
	Bulldozed & Dis.	.800	.660	.137	.020		.404	11	23.70	8.40
	Disced & Bedded	.767						7		
	KG, Chopped, Burn	.190						3		
	Logged & Burned	.305	.182	.050	.010		.212	21	12.44	.62
Southern Miss. Valley (134) Silty Uplands	Undisturbed						.005	480	.85	.12
	Burned	.115	.004				.060	12	10.18	.43
	Grazed						.165	95	24.60	9.75
	Logged	.024	.008	.010	.005		.012	90	2.04	.11
	Skid Trails	.567	.011				.288	7	14.00	4.20
Alabama & Miss (135) Blackland Prairies	Undisturbed						.012	95	.71	.00
	Burned	.037	.003				.020	10	1.18	.01
	Grazed						.106	37	6.23	2.87
	Logged	.047	.129	.004			.060	27	3.52	.35
	Spur Roads	.505	.700	.200			.478	5	9.96	.10
Southern Piedmont (136)	Undisturbed						.006	369	.55	.01
	Burned		.007	.011	.007			18		
	Grazed						.122	13	11.19	1.40
	Logged	.040	.074	.011			.042	120	3.85	.76
	Spur Roads	.475	.532	.750	.002		.440	14	33.34	8.34
	Skid Trails	.840	.700	.271	.007		.455	28	48.94	15.92
	KG Bladed	.845	.547	.401	.020		.453	33	41.56	12.47 — 30%
	Disced	.750	.430	.125	.010		.329	8	30.18	7.44
Carolina & Georgia Sand Hills (137)	Undisturbed						.003	121	.07	Trace
	Burned	.013	.010	.008			.010	14	.22	.01
	Logged	.008	.023	.014	.013	.005	.013	57	.29	.01
Gulf Coast Flatwoods (152)	Undisturbed						.003	26	.02	.00
	Logged	.237	.077				.157	13	1.26	.11
	Spur Roads	.892	.500	.990			.794	9	10.34	1.44
Atlantic Coast Flatwoods (153)	Undisturbed						.016	329	.13	.00
	Grazed						.010	4	.08	.00
	Logged	.053	.066	.227	.010		.089	72	.74	.00
	Spur Roads	.553	.900	.290		1.000	.686	10	11.92	1.31
	Skid Trails	.227	.124	.090	.052	.016	.102	18	.39	.00
	Chopped	.380	.202				.291	6	2.43	.00
	KG & Chopped	.450	.004				.250	3	2.09	.00
	KG & Bedded	.993	.269	.050	.005		.329	19	2.75	.27

1/ This is an estimate of all sediment that reaches the stream. Most sediment measurements are suspended sediment which would include only the fine particles (silt, clay, and fine sand) and would therefore, be somewhat lower than shown.

TABLE 5. Weighted Erosion Rates and Relative Contribution of Forest Practices to Forest Sediment Yield

River Basin	Weighted Average Er. Rate T/A/Y	Forest Sediment P.P.M.	Percent of Forest Sediment by Source						
			Un-disturbed	Logged	Skid Trails	Spur Roads	Fire	Graz-ing	Site Prep.
Alabama	3.6	84	Trace	5	22	2	1	2	68
Cape Fear	0.4		Trace	20	11	11	28		30
Green	1.7		2	4	30	24	1	39	
Obion-Forked Deer	3.0		3	3	1	1	Trace	92	
Santee	0.7	34	Trace	1	7	2	10		80
St. Francis	1.2	9	1	14	10	27	1	47	
SW Louisiana	0.5		0 1/	2	38	Trace	1	Trace	
Yazoo	1.0		0 2/			37		21	

1/ Flood plain scour was responsible for 59 percent of sediment for forested area.

2/ 42% of the sediment is from erosion on old abandoned farm land being invaded by forest, but not yet stabilized by forest.